



# Technology Demonstration Missions— Bridging the Technology Gap

Technology development progresses through stages that fall under several categories: idea inception and initial formulation; proof-of-concept testing; demonstration of mature technologies in relevant environments; and infusion of the technology into future missions.

NASA's Technology Demonstration Missions program bridges the gap between ground demonstration tests and final flight testing in an environment relevant to those the technologies are expected to operate in — space — to reduce the development risk for future missions and to provide the final infusion of cost-effective, revolutionary new technologies into robust NASA, government and commercial space programs.

The Technology Demonstration Missions program office, managed by NASA's Marshall Space Flight

Center in Huntsville, Alabama, is overseeing a portfolio of technology demonstration flight and ground projects led by NASA teams and industry partners across the country. The program is part of NASA's Space Technology Mission Directorate.

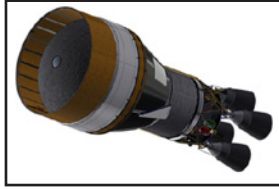
The TDM program focuses on crosscutting technologies that meet the needs of NASA and industry by enabling new missions or greatly enhancing existing ones. Chosen technologies are thoroughly ground-tested and readied for flight testing — reducing risks to future missions, gaining operational heritage and continuing NASA's long history as a technology leader. These technologies will enable future NASA missions to pursue bolder goals; make human missions safer and more rewarding; and enable new expansion of space industry in the government and U.S. commercial sectors.



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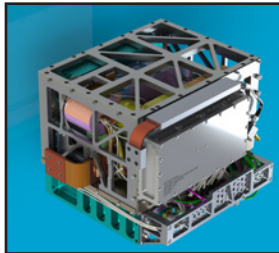
### Composites for Exploration Upper Stage (CEUS)

The Composites for Exploration Upper Stage ground-demonstration project will use lightweight composite materials in the design, build and test of liquid hydrogen tank skirts of the same scale that would be needed for use on NASA's Space Launch System Exploration Upper Stage. The goals of CEUS include demonstrating and validating the manufacturability, structural margins, thermal isolation improvements and inspection techniques of large-scale composite structures for possible use in the SLS program or other launch vehicles and space structures. Using composite material applications and manufacturing techniques instead of analogous metallic materials could reduce the overall mass of a launch vehicle, allowing for a higher mass of payload to be delivered for the mission.



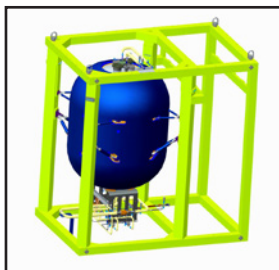
### Deep Space Atomic Clock (DSAC)

The Deep Space Atomic Clock project will demonstrate in space a small, ultra-precise, mercury-ion atomic clock 50 times more accurate than today's best navigation clocks. It will provide the time and frequency stability needed for the next generation of deep-space navigation and radio science missions, and potentially for future Global Positioning System satellites. This technology promises to improve the quality and flow of mission data by enabling a shift to a more flexible radio navigation architecture, freeing precious communications bandwidth currently reserved for navigation. Launch to low-Earth orbit as a hosted payload is planned for 2016 in partnership with NASA's Space Communications and Navigation Program and the U.S. Army Space and Missile Defense Command.



### Evolvable Cryogenics Project (eCryo)

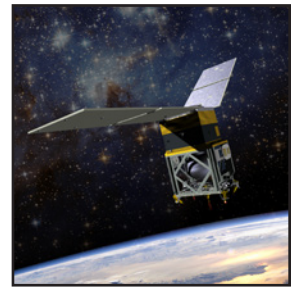
The Evolvable Cryogenics ground-demonstration project will validate new cryogenic fluid management technologies for NASA's Space Launch System and make use of large-scale systems to assess performance of technology to reduce cryogenic propellant boil-off, multilayer



insulation, propellant fluid level gauging, an integrated vehicle fluids system, analytical models and more. This technology advancement will provide significant improvement for long-duration, in-space missions by extending the cryogenic fluid storage and management capability. Near-term benefits exist for SLS in the Exploration Upper Stage design, and eCryo advancements offer design benefits for future use in missions such as the Mars Transfer Stage and Cryogenic Propellant Depot.

### Green Propellant Infusion Mission (GPIM)

The Green Propellant Infusion Mission project is the nation's premier spacecraft demonstration of a new high-performance "green" fuel and propulsion system — a more environmentally friendly alternative to the more toxic conventional fuel hydrazine as propellant. This technology promises improved performance for future satellites and other space missions by providing for longer mission durations, increased payload mass and simplified pre-launch spacecraft processing, including safer handling and transfer of propellants. Launch to low-Earth orbit is planned for 2016, in partnership with the U.S. Army Space and Missile Defense Command.



### Laser Communications Relay Demonstration (LCRD)

The Laser Communications Relay Demonstration project will advance optical communications technology, which will greatly improve the data transmission speed to and from space, expanding industry's capability to produce competitive, high-value optical communications systems and components. The technology, two optical-communications space terminals and associated electronics, will communicate with one or more ground stations during the demonstration and also will enable communications with other spacecraft in low-Earth orbit. The LCRD technology is expected to be implemented into next-generation space communication relays. Launch to geosynchronous Earth orbit as a hosted payload on a commercial spacecraft is planned for 2018 in partnership with NASA's Space Communications and Navigation Program.



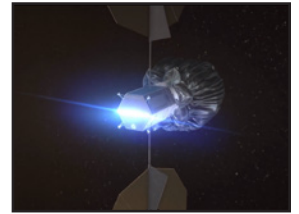
## Low-Density Supersonic Decelerator (LDSD)

The Low-Density Supersonic Decelerator project demonstrates the use of inflatable structures and advanced parachutes that operate at supersonic speeds to more efficiently slow down a spacecraft navigating through planetary atmospheres prior to landing. These new supersonic inflatable and parachute decelerators will increase capability for landed payload masses on Mars. They also will allow for higher-altitude landings and access to a larger portion of the Red Planet's surface, enabling improved targeting of safe landing sites. These new technologies are suitable for infusion into future Mars lander missions, greatly extending performance capabilities. Continued flight testing is planned through 2015. Infusion customers include NASA's Science Mission Directorate and NASA's Human Exploration and Operations Mission Directorate.



## Solar Electric Propulsion (SEP)

The Solar Electric Propulsion project is developing large solar arrays, power processing units and high-power electric thrusters that are critical technologies to enable cost-effective future in-space propulsion transfer stages, such as robotic missions to redirect an asteroid into lunar orbit for study by humans; science missions; commercial use to service and reposition orbital communications satellites; and a variety of robotic and crewed missions to Mars or other solar system destinations. A SEP-powered spacecraft will weigh much less than traditional spacecraft and require a much lower propellant mass be carried for the mission. That allows each launch vehicle to carry more supplies or science instruments and potentially reduces launch costs due to its lower mass and volume.



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